Wireless 911 for Telecommunicators

A reference resource provided by the North Carolina 911 Board

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Introduction

Wireless E911 presents telecommunicators with significantly different challenges than those associated with wireline E911. The single phone number/single street address MSAG-generated ANI/ALI data presented by a wire*line* E911 call doesn't change once it is presented. The ALI screen for a wire*less* E911 call, however, unlike that of its wireline equivalent, is likely to change, often many times, during the course of a call. The telecommunicator must know how to distinguish a wireless E911 call from its wireline counterpart based upon the ANI/ALI presentation, and how to utilize the wireless ANI/ALI data that is provided to maximum effect. Must the telecommunicator necessarily master all the protocols and interfaces and data streams used to deliver that data? Absolutely not; that is for the technical folks to understand and implement. Should he or she possess a basic understanding of how that data is collected and presented? Absolutely; without that basic understanding, the data could easily be either misinterpreted or simply misunderstood.

Wireless 911 Legislation

The FCC's First Notice of Proposed Rulemaking (NPRM) regarding wireless 911 was issued October 19, 1994, in response to concerns voiced by NENA, APCO, NASNA (National Association of State Nine One One Administrators), and the PCIA (Personal Communications Industry Association). The FCC recognized these agencies' concerns that PSAPs needed to be able to locate wireless 911 callers when those callers either didn't know their location or were unable to speak to convey it.

The FCC's First Report & Order, CC Docket 94-102, was released December 1, 1997, as the first step toward ensuring nationwide compatibility among wireless 911 emergency calling systems. It required wireless service providers to implement caller (handset) location determination capability in two stages, or phases. Phase I required delivery to the appropriate PSAP the telephone number of the handset originating the 911 call (callback number) and the location of the cell site/sector receiving the 911 call. Phase II required delivery of the latitude and longitude of the caller to the appropriate PSAP. Accuracy requirements differed depending upon the location technology solution used by the wireless carrier. Five subsequent Report & Orders have refined some requirements to reflect changes/improvements in the technology and implementation.

One of the mandates of the federal legislation was that wireless service providers (WSP) and the wireline local exchange carriers (LEC) providing connectivity to the PSAPs must be guaranteed full cost recovery for any expenses they incurred in deploying wireless 911. Obviously, such a guarantee at an individual PSAP level would be very difficult, if not impossible, to provide. To address that issue in North Carolina, the NC General Assembly in 1998 passed Senate Bill 1242 providing for creation of a State Wireless 911 Fund (by levying an $.80/month surcharge on every cell phone) and the Wireless 911 Advisory Board to administer the fund. This bill defined the purpose of the fund and the rules governing distribution of its assets. Once passed, it became Article 2 of NCGS Chapter 62A, the Public Safety Telephone Act. The FCC ultimately rescinded the requirement to provide cost recovery to the WSPs, making it optional. North Carolina elected to continue to provide cost recovery to the WSPs as well as the PSAPs.

In 2007 the North Carolina Legislature passed House Bill 1755, creating a 911 Board modeled after and replacing the Wireless 911 Board to administer, collect, and distribute revenues from a single, statewide 911 service fee for all types of voice communications services, wireline or wireless. The new legislation went into effect on January 1, 2008.

Building blocks

Wireline E911:

The fundamental concept of *wireline* E911 is relatively straightforward. Each telephone number is associated with a master street address guide (MSAG) record containing an Emergency Service Number (ESN). Each ESN is assigned to an Emergency Service Zone (ESZ), a specific geographic area within a given PSAP's jurisdiction. The combination of responding agencies, i.e. response scenario, to any request for service in that ESZ is unique.

When an E911 call originates from a wireline telephone, the telephone switching equipment recognizes that it is an E911 call and sends it to the phone company's 911 selective router (also referred to as a tandem switch). The selective router consults its database (the Selective Router Database, or SRDB), finds the ESN assigned to that phone number, and using the ESZ attributes unique to it, routes the call to the correct PSAP and suggests the appropriate responding agencies. Additionally, using the wireline MSAG address record, the telephone subscriber and address information can be retrieved by the PSAP's customer premise equipment (CPE) from the ALI database (whether LEC maintained or PSAP maintained) for presentation with the phone number and ESN on the telecommunicator's ANI/ALI interface.

Occasionally data drops will result in "record not found" messages, or errors in recording MSAG information in the ALI database may present incorrect ALI data to the telecommunicator, but by and large the ANI/ALI data provided with wireline E911 calls is very stable and reliable. Information fields in the ALI screen consistently populate with the same type of information, i.e. the phone number will always appear in the same location on the ALI screen, as will the street number, street name, city, etc. Once the ALI screen is populated, nothing on it changes. The same cannot be said for wireless E911.

Wireless E911

Because wireless phones are, by definition, mobile, calls placed from them will rarely come from the same location. While the mobile handset phone number will always remain the same no matter where the call is placed, and in conjunction with the handset's electronic serial number will be associated with the wireless service provider that initialized the phone, it may be used anywhere in the country. Therefore, since the phone number cannot be linked to an individual ESN based on a (nonexistent) fixed address location recorded in an MSAG, a different method of determining which PSAP to route an E911 call to must be provided to the selective router.

Wireless E911 call routing

Selective routing of any E911 calls, whether wireline or wireless, must reference some sort of geographic information, since every PSAP serves only a specific geographic area. In other words, a selective router database must be able to reference some sort of a fixed geographical point in order to determine which PSAP should receive a given wireless E911 call. Since all wireless calls become wireline calls as soon as they hit a tower, the logical first step in solving this wireless E911 location problem is to utilize the physical tower location in some fashion. That is key to wireless E911 location determination functionality.

Since telephone switching equipment is designed to recognize telephone numbers and make switching choices based upon them, the use of a "telephone number" to provide tower identification in the wireless environment seems obvious. It is, indeed, the starting point the wireless telephone providers have chosen to use to meet FCC requirements for wireless E911 location determination functionality. But the "telephone number" assigned to the tower equipment receiving and forwarding the E911 call is not a bonafide phone number, since it is not assigned to a telephone per se; i.e. it cannot be called. It is an identification number only. Since it looks identical to the ANI information presented on a wireline E911 ANI/ALI interface, it is called a *pseudo-ANI*, or false ANI. For simplicity's sake it is most often abbreviated *p-ANI*.

For selective routing purposes, a p-ANI is associated with every wireless transceiver mounted on a tower by the wireless service provider's mobile switching center (MSC) serving that tower. Each p-ANI is associated with a wireless ESN that identifies the PSAP serving its cell sector coverage area. When an incoming wireless E911 call hits a cell sector (or omnidirectional) transceiver, its p-ANI gets passed through the MSC to the selective router database. The SRDB uses the ESN associated with the p-ANI to route the call to the proper PSAP. Although the selective routing part of the wireless E911 call is then complete, the p-ANI's usefulness is not yet exhausted. It is also used to retrieve from the host ALI database (i.e. the PSAP's database) the street address of the tower and present it on the ALI screen along with the cell sector information.

Every time a call is placed from a mobile handset, both the handset telephone number and the handset electronic serial number are transmitted to the tower receiving the call. Within the 911 profession, the handset telephone number is commonly referred to as the mobile directory number (MDN), calling party number (CPN), or call back number (CBN). It appears on the telecommunicator’s ALI screen, though its location on the screen depends upon the equipment used by the wireline provider serving the PSAP and the signaling system utilized by the WSP sending the call, which is addressed in more detail later in this document. The electronic serial number is used to identify the wireless carrier providing service to the handset.

Wireless cell types and coverage

Wireless cell sites can either be omnidirectional or sectored. Omnidirectional cells serve a roughly circular coverage area. Signals are received from all points of the compass around the tower. Sectored cell sites divide that circular area into roughly wedge shaped coverage areas, like pieces of a pie.

Omnidirectional cells are well suited to rural applications where a large coverage area is desirable and call density is low. Sectored cells are well suited to urban environments where a focused coverage area is desirable and call density is high. Each sector in a sectored cell is capable of receiving as many concurrent calls as a single omnidirectional cell, which is important as calling populations become concentrated, resulting in higher call density. An added plus for sectored cells is the ability to determine the direction from which a call came through use of directional antennas. Instead of the call potentially originating in a large circular coverage area around the cell tower, its point of origin is within the limited coverage area of the sector, which can be directly associated with a compass point (North, South, East, West, etc).

Location technology

When 94-102 dictated a timeline for wireless 911 location determination capability, the technology necessary to accomplish that was still in development. Possible solutions to the problem included adapting existing terrestrial network equipment to perform the calculations and/or using the satellite based Global Positioning System that had been functioning since the late seventies (1970s). While GPS offered considerable promise, adapting cell phones to utilize it still presented considerable challenges. The FCC stipulations were, before waivers:

For carriers using a handset-based Phase II location technology, the Carrier shall:

- Begin selling and activating compliant handsets no later than October 1, 2001
- Ensure that at least 25 percent of all new handsets activated are compliant no later than December 31, 2001
- Ensure that at least 50 percent of all new handsets activated are compliant no later than June 30, 2002
- Ensure that 100 percent of all new digital handset activated are compliant no later than December 31, 2002 and thereafter
- By December 31, 2005, achieve 95 percent penetration of compliant handsets among its subscribers.
- When a PSAP request has been received, and within 6 Months of the request (or by October 1, 2001, whichever is later), the Carrier shall:
  - Install any hardware and/or software in the network and/or other fixed infrastructure, as needed, to enable the provision of Phase II E9-1-1 service
  - Begin delivering Phase II E9-1-1 service to the PSAP
- Accuracy and reliability shall be:
  - 50 meters for 67 percent of calls
  - 150 meters for 95 percent of calls

For carriers using a network-based Phase II location technology, the Carrier shall as of October 1, 2001:

- Within 6 months of a PSAP request, carriers employing network-based location technologies must provide Phase II information for at least 50 percent of the PSAP's coverage area or population.
- Within 18 months of a PSAP request, carriers must provide Phase II information for 100 percent of the PSAP's coverage area or population.

- Accuracy and reliability shall be:
  - 100 meters for 67 percent of calls
  - 300 meters for 95 percent of calls

GPS based:

GPS location determination is provided by a constellation of 24 satellites orbiting approximately 12,000 miles above the earth. Initially developed and deployed by the Department of Defense (DOD) as a military navigation system called **NAVSTAR**, for **Nav**igation **S**atellite **T**iming **A**nd **R**anging, it was originally intended to aid navigation, troop deployment, and artillery fire. Selective Availability (SA) was an intentional degradation of GPS signals once imposed by DOD to prevent adversaries from using the system against the United States and its allies. An executive decree in the 1980s made GPS available for civilian use.

SA was ultimately turned off in May of 2000, greatly improving the accuracy of civilian GPS receivers.

A fix (signal reception) from 4 satellites is necessary to acquire accurate longitude, latitude, and altitude (elevation) coordinates through a process known as trilateration (three dimensional triangulation).

- Pros
    - Very accurate with a good satellite fix (hence the more stringent accuracy requirements in 94-102)
    - Does not require access to multiple towers
- Cons
    - May require 15-30 seconds to calculate lat/lon (newer equipment is nearly instantaneous)
    - Requires line of sight to multiple satellites
    - Handsets require GPS chip that adds to handset cost
    - Phones without GPS chips *cannot* provide location information

Network Based:

While GPS functionality built into the handset appealed to some carriers, adapting the wireless provider's existing land based equipment (its tower network) to perform that function without handset involvement appealed to others. Network solutions rely on triangulation among towers, direction of signal, and time difference of arrival (TDOA).

- Pros
    - Can calculate lat/lon very quickly
    - Does not require line of sight to satellites
    - No GPS chip cost
    - Older phones *can* provide location information
- Cons
    - Needs access to multiple towers not located in a straight line (as along highways) to accurately calculate lat/lon
    - Less accurate than GPS

Hybrid (A-GPS, or Assisted GPS):

A hybrid (A-GPS) system utilizes both GPS and network based location determination solutions. In so doing, it offers some of the benefits of each.

- Pros
    - Good location calculation speed due to network elements (better than GPS alone)
    - Good location calculation accuracy due to GPS elements (better than network alone)

  - Hybrid GPS chip is less expensive and draws less power than chips used in exclusive GPS solution
- Con
  - As with exclusive GPS solution, older phones without GPS chips still *cannot* provide location information

ALI Screen Information: What does a wireless 911 call provide?

The key to determining whether ALI data is Phase I or Phase II lies in the Class of Service, abbreviated CLAS or COS. Class of service is denoted on a wire*line* ALI screen by abbreviations such as:

- RESD for residential phones
- BUSN for business phones
- COIN for pay phones
- ELEV for elevator phones
- PBX for private branch exchange phones
- POOL for public swimming pool phones

Wireless calls in NC use MOBL, CELL, WRLS, WPH1, or WPH2 as abbreviations for classes of service, depending upon the capabilities of the wireline LEC network. MOBL or CELL indicates Phase 0, WRLS indicates Phase I or less, WPH1 indicates Phase I info from a Phase II deployment, and WPH2 indicates that Phase II data is being presented. All calls less than WPH2 should be re-bid to determine whether or not Phase II information is available.

Re-bid is the most commonly used term referring to the process of asking the PDE to provide updated location information. It is also frequently referred to as re-try, re-transmit ALI, request ALI, or query ALI. It is necessary because some PDEs require 15-30 seconds to acquire a good lat/lon fix, while most call setups take only 5-6 seconds. Re-bidding is an essential step in determining if location information being presented is Phase I or Phase II information, as well as assessing the relative accuracy of the lat/lon values of a WPH2 call. Some CPE vendors offer an automatic re-bid feature, allowing the telecommunicator to focus on other elements of the call. Subsequent re-bids (after the first one) at appropriate intervals will either improve the location accuracy until lat/lon values stop changing appreciably (static location) or continue to change appreciably enough to indicate that the caller is moving (if MCLU is available).

Latitude and Longitude Coordinates

Lines of latitude and longitude comprise a grid upon which any point on the surface of the earth can be plotted. Although the grid is represented by imaginary lines superimposed on the face of the earth that appear to measure distances, the unit of measurement for both latitude and longitude is the degree, just as in circular geometry.

Lines of latitude (where the **Y** coordinate is plotted) run east and west (horizontally) along the surface of the earth and reference a distance from the equator determined by the angle created between that point, the center of the earth, and the equator. The equator, which is the baseline for all latitude values, is an imaginary line circling the earth midway between the north and south poles. Every degree of latitude north of the equator is in the positive (+) range and every degree of latitude south of the equator is in the negative (-) range.

Some additional latitude information:

- All points along the equator have a latitude of zero (0) degrees.
- The north pole is +90 degrees and the south pole is –90 degrees.
- All latitude (y) coordinate values within the United States are positive values
- Each degree of latitude is divided into 60 equal parts called minutes.
- Each minute is further divided into 60 seconds (and seconds may be further divided into 60 sub-seconds).

Lines of longitude (where the **X** coordinate is plotted) run north and south (vertically) along the surface of the earth and reference a distance from the Prime Meridian determined by the angle formed between that point, the center of the earth, and the Prime Meridian. The Prime Meridian, which is the 'base line' for all longitude values, is an imaginary reference line connecting the north and south poles and passing through Greenwich, England. The International Dateline is a continuation of the arc described by the Prime Meridian on the 'back side' of the earth, representing a neutral (neither positive nor negative) longitude value of 180 degrees.

Some additional longitude information:

- All points on the Prime Meridian have a longitude of zero (0) degrees.
- All points on the International Dateline have a longitude of 180 degrees.
- Any point east of the Prime Meridian is in the positive (+) range and anything west of the Prime Meridian is in the negative (-) range.
- All longitude (x) coordinate values within the United States are negative (-) values.
- As with latitude, each degree of longitude can be further divided into 60 minutes, each minute into 60 seconds, and each second into 60 sub-seconds.

Often the phrases "lat/lon (long)" or "X/Y" are used to describe an intersection point on the grid. This causes some confusion because "lat" is NOT the X coordinate and "lon" is NOT the Y coordinate. It is actually just the reverse! If you say “lat/lon” you are really saying “Y/X“, and vice versa. Another clue is that longitude (x) values in the United States are always negative values, preceded by a minus (-) sign, while latitude (y) values are always positive, preceded by a plus (+) sign.

While values expressed in degrees, minutes, and seconds (DMS) work well for manual plotting and calculation, those units of measurement are awkward for machines to utilize. Earth coordinate values generated by machine are typically expressed as decimal degrees. While decimal degrees work well for electronic plotting, they are awkward to use for manual plotting, and occasions may arise when they must be converted to DMS for that purpose. The following illustrates how to easily accomplish that conversion.

Problem: Convert the decimal longitude (x) value -79.562341 to DMS notation.

- The degree value for DMS or decimal notation is the same, in this case -79°, the whole number to the left of the decimal point.
- To calculate the minute(s) value from the decimal degree extension, simply multiply the decimal value by 60, in this case .562341 x 60=33.74046.
- The whole number to the left of the decimal in the product is the minute(s) value, or 33’.
- To calculate the second(s) value, again multiply the decimal value of the product by 60, in this case .74046 x 60=44.4276.
- The whole number to the left of the decimal in the product is the second(s) value, or 44”.
- Sub-seconds can be calculated the same way, but a final DMS notation of -79° 33’ 44.43” will provide sufficient accuracy for a manual plot.

Accuracy refinement tools

Although multiple re-bids at appropriate intervals should return successively more accurate lat/lon coordinates, other fields on the ALI screen can also help a telecommunicator assess the accuracy of the plot when LECs pass the appropriate information.

UNC (or COF) is the abbreviation for uncertainty factor. It is also the ALI screen field label where that information is presented. It represents how close the lat/lon plot is to the caller’s location, expressed in meters. For example, a UNC of 12 indicates that the caller should be within 12 meters of the point indicated by the latitude and longitude coordinates. Obviously, the smaller the radius the better the accuracy. No federal standard for UNC currently exists within 94-102, although many wireless carriers are providing it. Even when provided by the wireless carriers, UNC is not currently being passed to PSAPs by some LECs whose network equipment does not permit it.

ZUNC (or ELV) is the radius expressed in vertical meters within which the altitude (elevation) coordinate (z coordinate) is accurate. In other words, it is the vertical equivalent to the horizontal UNC. No federal standard for ZUNC currently exists within 94-102, but some wireless carriers utilizing a GPS based location determination solution are passing a Z coordinate referencing sea level and a ZUNC to the PSAPs where the wireline LEC supports it.

CF (or COP) represents the percentage of confidence the PDE has in the accuracy of the reported location. The better the CF the more confidence the telecommunicator can have in the location information. No federal standard for CF currently exists within 94-102. In many PDE systems generally available and deployed to date, confidence, when sent to the MPC, is either set at 67% or 95% to indicate whether the location meets the 67% or 95% accuracy measurement required by the FCC. This is not, however, a standard. Nextel, for example, currently uses 38% for all calls, although their UNC (or COF) is usually very accurate. It is imperative that you know which measurement standard a particular vendor is using before considering its value. CF works in conjunction with the UNC and should never be used without the corresponding UNC.

The Phases of wireless E911 implementation, and the implications of each

Phase 0: CLAS MOBL, CELL, or WRLS

Before 94-102 laid the groundwork for wireless Phase I and Phase II, calls were routed to the appropriate PSAP without the display of any caller information. It has in retrospect been labeled Phase 0. It was already ahead of basic wireline 911 because the very existence of the p-ANI ensured routing to the appropriate PSAP (provided the WSP had it correctly configured). Calls could come over either 10 digit translation lines or 911 trunks. If the PSAP subscribed to caller ID with its LEC for the 10 digit lines, the telephone number of the mobile device might be provided as caller ID, though not a true ANI. Such calls, when received on 911 trunk lines, should still be re-bid in the hope of improving the CLAS.

Phase I: CLAS WRLS or WPH1

As required by 94-102, the ALI screen for a Phase I call shows:

- A p-ANI
- Name of wireless carrier
- Class of service will show WRLS or WPH1, depending on the deployment capability
- Address of cell tower being accessed
- Sector of the accessed cell tower
- MDN (CBN) of wireless phone being used to call 9-1-1

Phase I information can be delivered to the CPE using several different signaling systems to provide the ALI data. Each signaling system delivers data to the CPE in a different fashion, sometimes along the same path as the voice, other times along dedicated digital data pathways. Each method of delivery has unique characteristics that a telecommunicator should at least be aware of, though not necessarily fluent in.

CAS

Used for Phase I, Call Path Associated Signaling (CAS) sends 20 digits (p-ANI and CBN) of data across the voice call path along with the voice. While acceptable for Phase I data transmission, it cannot accommodate the additional data—latitude and longitude—required for Phase II. Implementing CAS requires upgrades to selective routers, trunking between selective routers and PSAPs, and PSAP CPE to accommodate the extra ANI digits. One substantial benefit is that it supports one-button callback even if an ALI failure occurs, since the CBN is sent along the voice path, not provided through an ALI dip. One significant drawback, however, is that since the callback number is part of the ANI spill rather than part of the ALI return, it may be displayed only in the dynamic interface of the call, and not stored in the permanent ALI record. In such a case, it disappears as soon as the voice call is concluded.

HCAS

Also used for Phase I, Hybrid Call-Path Associated Signaling (HCAS) can be used when a carrier can only deliver CAS and a PSAP can only process NCAS. Simply put, the SR translates CAS input into NCAS output. Use of HCAS is dependent upon the LEC’s ability to implement the solution within its network, and may not be available in all areas.

NCAS

Non Call-Path Associated Signaling (NCAS), necessary for Phase II, sends voice and a routing number to the PSAP over the voice call path, but also utilizes a separate digital data path to provide the CBN through ALI. NCAS uses a Service Control Point (SCP) to provide routing of all data to both the Mobile Switching Center (MSC) and the ALI database. NCAS does not require the upgrades associated with CAS, and is capable of providing full Phase II functionality as well as Phase I functionality. It does not support one-button callback in the event of an ALI failure (CBN is provided by ALI dip, not along the voice path).

Phase I caution:
The ALI screen for a Phase I call may show a CLAS of WRLS, yet still provide latitude and longitude coordinates. Since the CLAS is not WPH2, the call is <u>not</u> a Phase II call, and those coordinates do <u>not</u> represent the caller’s location. In such a situation those coordinates represent either the location of the wireless tower

itself, or the cell centroid of the sector (nominal center of the sector propagation footprint) receiving the call. You should always re-bid such a call in an effort to acquire a WPH2 CLAS and upgrade the lat/lon coordinates to the caller's location.

Phase II: CLAS WPH2

As required by 94-102, the ALI screen for a Phase II call shows:

- A p-ANI
- Name of the wireless carrier
- Initial CLAS may be WRLS or WPH1, which must be re-bid to return WPH2
- Address of cell tower being accessed
- Sector of the accessed cell tower
- CBN of the wireless phone being used to place the call
- Latitude and longitude of caller

Phase II caution:
Newer position determining equipment (PDE) can sometimes calculate x/y coordinates within the 5-6 second call setup time frame, resulting in a WPH2 CLAS in the initial ALI presentation. Although they are the coordinates of the caller's location, rather than a cell tower location or cell sector centroid, a re-bid is still desirable to confirm/refine the accuracy of those coordinates.

Mapping

94-102 requires that a PSAP be capable of receiving and utilizing Phase I or Phase II data before requesting wireless 911 implementation, so that location data can be translated into a physical incident location for responders. Although digital mapping provides the most efficient and accurate way to determine an incident location, it is not mandatory. Manual plotting of either cell sector coverage areas or lat/lon coordinates on a paper map adheres to the letter of the law, although very cumbersome in the heat of a 911 call. Manual plotting becomes even more cumbersome when tracking a moving caller's location.

Geographic Information Systems (GIS)

Many, if not most, larger PSAPs today utilize digital GIS. Although digital GIS is, and always will be, helpful in the enhanced wireline 911 environment, its importance is magnified with wireless 911. In the absence of fixed address references for incident locations, the visual references afforded by GIS plotting of lat/lon coordinates acquire a much more significant importance in wireless 911.

Creative solutions to the need for GIS in the PSAP for wireless 911 run the gamut from generic, stand-alone, retail mapping software applications to highly sophisticated, CAD integrated, jurisdiction-specific applications. Some CAD/GIS applications require you to manually update plots each time you re-bid ALI. Others will automatically update plots each time you re-bid ALI, whether manually or automatically. High end, fully featured CAD/GIS integrated applications can even convert a lat/lon point into the nearest street address with an offset factor (direction and distance of the point from the address).

GIS and Phase I

Although GIS is almost always associated with Phase II location plotting, with proper data provisioning, it can also be very helpful in the Phase I call reception environment. With cooperation and collaboration among the GIS vendor, the wireless carrier, the PSAP 911 addressing coordinator and the serving ALI database provider, cell site and cell sector coverage areas can be graphically displayed with only Phase I information. Although such a display doesn't pin-point the caller's location, it does reduce the potential response area to within reasonably finite boundaries.

GIS and Phase II

While latitude and longitude coordinates don't have 'addresses', the beauty of digital mapping is that call takers can visualize where that point is in relation to known map features such as streets, bodies of water, railroad tracks, etc. With an orthographic layer in the digital map, those features can be photographic. Depending upon the interface between the serving ALI database (often provided by the 911 LEC) and the PSAP CPE, Mid Call Location Updates (MCLU) can track moving callers.

Putting it all together

Review:

1. Caller dials 911.
2. Regardless of call-path signaling method, call is routed to appropriate PSAP.
3. Phase 0 call provides only voice with a CLAS of MOBL, CELL, or WRLS.
4. Phase I provides CBN, cell site/sector location, and wireless provider identification, with a CLAS of WRLS or WPH1.
5. GIS applications with the proper feature sets may graphically display the cell site or cell sector coverage area of the Phase I call.
6. If the CLAS is MOBL, WRLS, or WPH1 a re-bid should be performed after 15-30 seconds, even if latitude and longitude values have been provided in the initial ALI presentation.
7. If the CLAS changes to WPH2 after a re-bid, the attendant lat/lon values reflect the caller's location.

8. The uncertainty factor and confidence factor, when provided, can indicate relative accuracy of the lat/lon coordinates.
9. Re-bids should be performed at appropriate intervals to either refine location accuracy or determine if the caller is moving.
10. GIS applications will plot the Phase II caller's actual location rather than just cell site/sector footprint.

Key elements to consider

- Always pay close attention to the CLAS.
- If the CLAS is not WPH2 and lat/lon is presented, it does **NOT** represent the caller's location.
- If you know the wireless provider uses exclusively network based location technology, you may be able to re-bid at shorter intervals than with a hybrid (A-GPS) or GPS only provider.
- Don't stop re-bidding until either your lat/lon coordinates (and/or your GIS plots) change only incrementally between re-bids or your UNC and CF report high certainty and confidence values.

Types of wireless phones

Subscriber owned and active phones (service initialized phones), whether local area or roaming, contract or pre-paid, will provide at least Phase I information if the PSAP has requested and received Phase I implementation from the WSP hosting the call. Since they are assigned an MDN, 911 telecommunicators can call them back if a 911 call is disconnected. This includes legacy phones, or those that predate Phase II implementation and do not have GPS capability.
If the phone is Phase II capable through a WSP using a GPS or hybrid Phase II location determination solution, and the PSAP has requested and received Phase II implementation from the WSP, then lat/lon coordinates will also be provided. If the phone is a legacy phone provided by that WSP before it implemented its GPS or hybrid Phase II solution, though, it will not provide Phase II information. If the phone (or service) is offered through a WSP using an exclusively network based solution, however, it will provide Phase II information even if it is a legacy phone.

Non-service initialized (NSI) phones are phones that are not able to place or receive non-911 calls because they are either no longer active under a subscriber contract or have exhausted any prepaid minutes under a prepaid plan. They do not have an active MDN, and do not afford 911 telecommunicators any way of calling them back if a 911 call is disconnected, but because the FCC mandates that any mobile phone be capable of calling 911 as long as it has a source of power, they are frequently used (or abused) for that purpose.

Possible NSI phone MDN displays

One MDN scenario presents the last phone number associated with the handset when it was initialized. In such an instance, calling that number will only connect you with the new owner of that reassigned number. Another scenario presents a string of zeroes. Unless you are receiving ANI failure messages in conjunction with that string of zeroes, that is a solid indicator that you are dealing with an NSI phone. Yet a third scenario (once an FCC requirement) presents a sequential string of numbers 1234567890. A fourth possibility is the number 911 in the NPA (area code) field followed by the decimal representation of the last seven digits of the handset's electronic serial number in the nxx-xxxx fields. That fourth possibility holds the most promise for potentially identifying who owned that handset when it was last initialized. It's a long process, but the logs of the field equipment that received and processed that call, i.e. sent it to the PSAP, contain all the data necessary for a willing WSP representative to backtrack and identify that phone's last recorded owner. It can also be used to deny service to that handset if it is being used for harassment or prank calls.

Tracing wireless 911 calls

Less than a decade ago, if you needed help from a WSP in identifying a phone's owner, you simply called the provider, identified yourself as a 911 telecommunicator, stated the reason you needed their help, and it was given to you. In the years it has taken for the number of wireless subscribers in the US to grow from 40 million to over 263 million, such information has become much more difficult to obtain. Now you must contact the WSP's subpoena compliance center, follow specific instructions (which differ from carrier to carrier), and fax written documentation of your request. You will still receive the information, provided you are patient enough. Just hope you have the luxury of time. Because you may *not* have the luxury of time, it is very important that your PSAP have subpoena compliance (exigent circumstances) policies in place for every WSP serving your jurisdiction. You should understand and be familiar with those policies before you need to use them. Any proprietary forms should be readily accessible so that you can quickly complete and fax them. You must also realize that the wireline LEC serving your agency cannot provide customer information about wireless customers. Its representatives don't have any access to that type of information, and they can't send what they don't have.

What else?

Telematics and ACN

By now all of us are familiar with OnStar and its telematics clones. While calls from their call centers are primarily voice only at present, enormous untapped potential awaits the widespread deployment of IP data connectivity between call centers and PSAPs. Automatic Collision Notification (ACN) can provide force of impact data, number of occupants data, and probable type and severity of injury data, as well as countless other types of data that can be enormously useful to first responders and trauma centers. The technology necessary to stream that data to PSAPs and trauma centers is already "old hat". The 911 community needs to implement the public safety network infrastructure, locally and nationally, to take advantage of it.

VoIP or VOI

Voice over internet protocol (VoIP), AKA voice over internet (VOI), is currently a big buzzword in 911. While 911 provisioning for VOI was initially a huge problem, and horror stories about its 911 inadequacies abounded, the IP technology it uses offers vast potential for providing much more information to the PSAP in Next Generation 911. Both APCO and NENA have taken pro-active stances on VoIP, actively seeking workable solutions through cooperation with IP experts since its inception. In so doing, they hope to avoid having to take a reactive approach like they had to do when wireless snuck up and blind-sided the 911 community with its exponential growth in the late 80s and early 90s.

Next Generation 911 (NG911)

Recognizing that new and innovative ways to call 911 have emerged, are emerging, and will continue to emerge, NENA and APCO have been exploring how these same technologies, service offerings, and capabilities may, or perhaps more accurately, will, revolutionize the delivery of all 911 calls. 911 as we know it today will virtually cease to exist, as these new and improved technologies provides features and integrations we currently only dream about.

Drive testing

Prior to deploying wireless 911, each WSP must perform test calls from each sector of each cell tower to ensure that wireless 911 calls route to the proper PSAP. This is accomplished by technicians physically driving to each of the cell sectors and placing an actual 911 call from that sector. PSAP personnel taking drive test calls must know the ALI format used in their center to properly relay test call data to the technicians performing the tests. Drive testing and scheduling should be a cooperative effort between the WSP and the PSAP, working together to agree on mutually acceptable dates and times for testing. PSAP personnel should not withhold information from a WSP technician who has properly identified him/herself, as that information is frequently essential to troubleshooting and correcting problems discovered during the drive testing.

Web Resources

National Emergency Number Association (NENA)
www.nena.org/

Association of Public-Safety Communications Officials (APCO)
www.apcointl.org/

National Association of State 911 Administrators (NASNA)
www.nasna911.org/

Cellular Telecommunications Industry Association (CTIA)
www.ctia.org

Federal Communications Commission (FCC)
www.fcc.gov/

North Carolina 911 Board
www.nc911.net

References

NENA Wireless Phase I & II Features and Functions Operational Information Document, NENA 57-50, Final 01/20/04

E911 Standard Operating Procedures for PSAPs, TeleCommunication Systems, Document Number: TCSW008, Release 10-0, 16 December 2004

PSAP Operations Guide for Wireless 911, June 2003, © 2003 Intrado Inc., Longmont, Colorado, USA

Glossary of acronyms

ACN	Automatic Collision Notification
ALI	Automatic Location Identification
ANI	Automatic Number Identification
APCO	Association of Public Safety Communications Officials
CAD	Computer Aided Dispatch
CAS	Call-path Associated Signaling
CBN	Callback number
CF	Confidence Factor
CLAS	Class of Service
CPE	Customer Premise Equipment
CPN	Calling Party Number
DMS	Degrees Minutes Seconds
ESN	Emergency Service Number
ESZ	Emergency Service Zone
FCC	Federal Communications Commission
GIS	Geographic Information System
GPS	Global Positioning System
IP	Internet Protocol
HCAS	Hybrid Call-path Associated Signaling
LEC	Local Exchange Carrier
MDN	Mobile Directory Number
MOBL	Wireless Phase 0 (class of service)
MPC	Mobile Positioning Center
MSAG	Master Street Address Guide
MSC	Mobile Switching Center
NCAS	Non Call-path Associated Signaling
NPA	Number Plan Area
NSI	Non-service initialized
p-ANI	pseudo-Automatic Number Identification
PDE	Position determining entity
PSAP	Public Safety Answering Point
SA	Selective Availability
SCP	Service Control Point
SR	Selective Router
SRDB	Selective Router Data Base
TDOA	Time Difference of Arrival
UNC	Uncertainty factor
VOI	Voice Over the Internet
VOIP	Voice Over Internet Protocol
WPH1	Wireless Phase 1 (class of service)
WPH2	Wireless Phase 2 (class of service)
WRLS	Wireless Phase 0 or 1 (class of service)
WSP	Wireless Service Provider
ZUNC	"Z" coordinate (elevation) uncertainty factor

Appendix 1

NC Embarq LEC Warning Line Class of Service Display for E2+ interface

MPC Response	Phase 2 Lat/Long	Message	COS	Comments
Yes	Yes	“WRLS PH 2”	WPH2	Phase 2 deployment with Phase 2 Position Source Returned
Yes	No	“WRLS PH2 LAT/LONG NOT AVAIL”	WPH1	Phase 2 deployment –with Phase 1 Position Source Returned / Initiate re-bid
Error Response	Not Applicable	“WRLS PH2 LAT/LONG NOT AVAIL”	WRLS	Error Response from MPC – COS is derived from Shell record / Initiate re-bid
Links down	Not Applicable	“WRLS PH2 NO MPC RESPONSE”	WRLS	No Response from MPC – COS is derived from Shell record / Initiate re-bid
Yes	No	“WRLS PH 1”	WRLS	Phase 1 deployment only
Not Applicable	Not Applicable	“Cellular Confirm Location”	MOBL	Phase 0